MSWG Meeting #5, 20-September-2019

Present: S. Albright, A. Alekou, F. Asvesta, H. Bartosik, J. Bernhard, C. Bracco, K. Cornelis, D. Cotte, H. Damerau, G.P. Di Giovanni, L. Gatignon, A. Gerbershagen, K. Hanke, V. Kain, E. Koukovini, M. Lamont, A. Lasheen, B. Mikulec, M. Vadai, F. Velotti

Agenda:

Link to the Indico Event:

- Approval of minutes – Karel Cornelis
- Main presentations:
  - Beam-beam observation during SPS collider run in the 1980's

The minutes from the last meeting were approved.

Main presentations:

Beam-beam observation during SPS collider run in the 1980's (K. Cornelis) - slides

Shortly after its initial commissioning, the SPS was transformed into a proton anti-proton (p-pbar) collider with low beta insertions in LSS4 and LSS5 for collisions at 275 GeV/c and later 315 GeV/c. The injection was at 26 GeV/c compared to the injection of the fixed target beam at 14 GeV/c, in order to avoid instabilities with the high intensity bunches. The Antiproton Accumulator (AA) accumulated over 24 hours just enough antiprotons to provide 3 bunches to the SPS with 0.8e10 particles per bunch, i.e. there was one fill of the SPS every 24 hours. Later the injector was upgraded to the Antiproton Colloector (ACOL) providing 6 bunches for the SPS with significantly higher intensity. The higher bunch intensity required the implementation of the pretzel scheme, which was using electrostatic separators to separate the beams along most part of the circumference. This lead to different tune footprints for protons and antiprotons due to different closed orbits resulting in feed-down effects in the chromaticity correction sextupoles, and their different intensity resulting in different beam beam tune shifts. An important finding of the SPS collider period was that the space charge at injection was inducing relatively large tune spreads as the beam intensity was concentrated in few bunches. It was found that reducing the line charge density in the SPS by bunch flattening was improving the beam lifetime and emittance preservation at low energy.

One of the important findings of operating the SPS as p-pbar collider was that the low intensity p-bar beam with smaller emittance was strongly affecting lifetime of high intensity proton beam with larger emittance. This could be attributed to dynamic scraping for beams with different transverse emittance, which affects mostly the beam with larger emittance because high order resonances mainly affect particles with large amplitude. Since the reduced proton lifetime was creating undesired background in the detectors, this phenomenon was studied in detail in a series of dedicated machine experiments clearly demonstrating the diffusion of particles after removing the beam halo in a controlled way using the collimators. It was also found that tune modulation due to noise and power converter ripple had an important effect on beam lifetime. Therefore, the active filters on the mains, sextupoles and bumper magnets had to be frequently tuned and the chromaticity of the machine was adjusted very close to zero.

The low-beta insertions of the SPS were re-built in 1986 to reduce beta* and the experiments were upgraded as the luminosity could be increased by almost a factor 10 in the final year of the SPS collider operation. An important observation from back then was that the crossing angle in the SPS was not imposing particular issues when the beams were colliding head-on.

The HERA collider could profit from the SPS experience, as the beam lifetime could be optimized by careful control of the beam size of protons and electrons.

Discussion:

M. Lamont asked how many times a fill was lost because of issues during the injection of the pbar beam. **K. Cornelis** explained that this happened not many times. Sometimes things went wrong in coast but otherwise the operation was relivately stable, in particular because before actually injecting pbars the machine and the injection systems were carefully checked and optimised using a proton beam in opposite direction to the pbars.

H. Bartosik asked if there was an observation that the vacuum had an impact on the emittance growth. **K. Cornelis** explained that the vacuum was not so critical for the emittance but rather for the background in the experiments.

Minutes by Hannes Bartosik